Advances in Engineering Research, volume 151
International Conference on Smart Solutions for Agriculture (Agro-SMART 2018)

Application of Method of Measuring Bioelectric Potential for Evaluation of Milk Fitness in Production of Curd Cheese

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Abstract—**The quality and yield of the finished product - cottage cheese - are influenced by various factors, including technological: the quality of raw milk, methods of coagulation of milk proteins, methods of processing the bunch, etc. Under the quality of raw milk for the production of cottage cheese, in the first place, it is necessary to understand the protein content in milk and its fractional composition. However, the qualitative and quantitative indicators of raw milk in Russia today can not ensure a high level of competitiveness of domestic producers in the world market. Therefore, an important place should be taken by questions of improving the quality of raw milk and its compliance with a set of indicators regulated by regulatory legal documents. A superficially localized biologically active centers on the body of cows can play a certain role in regulating the quality of milk, using which, by measuring the level of bioelectric potential, one can predict not only the physiological state of the animal, but also certain technological characteristics of the milk produced.**

Key words–raw milk; genotype of æ-casein; cottage cheese

I. Introduction

As shown by numerous studies, a multifactor criterion determining the quality of the finished product - cottage cheese, is the quality and safety of raw milk materials [2, 8, 11]. Under the quality of raw milk for the production of cottage cheese, in the first place, it is necessary to understand the protein content in milk and its fractional composition. For example, the use of milk with a low protein content (less than 2.8%) adversely affects the efficiency of production of cottage cheese, reducing the yield of finished products, and sometimes even its absence (flabby clot with poor or unseparated serum).

The fractional composition of milk proteins, especially the content of ß-casein, largely determines the expediency of producing cottage cheese. Studies of domestic and foreign scientists (Sulimova G.E. 1991, Miranda G. et al., 1993, Kaminski S., 1996, Princenberg E.M., et al., 1996, Iolchieva B.S., Seltsova V.I., 1999, Kalashnikova Yu.I., 2002, Yukhmanova N.A., 2004) indicate the importance of the B-allelic variant of the locus of the æ-casein gene in animals whose milk is intended for the production of protein dairy products. It is the B-allele that is associated with a higher protein content in milk, its better coagulation properties and greater yield of protein clots [1, 10, 14, 15].

In Western Europe (Germany, Holland), the choice for æ-casein as one of the important economic and technological characteristics of raw milk is included in the state programs for livestock development.

In the Russian Federation, only the total protein content is taken into account as requirements for raw milk for the production of cottage cheese (GOST R 52054 "Raw cow milk, technical conditions"). No less important criterion is the size of casein micelles, which depends on the stage of lactation. As the dispersion of the casein micelles increases, the total amount and hydrophilicity of the surface charges increase, which in turn increases their colloidal resistance (the amount of β-casein increases and the colloidal calcium phosphate decreases), hence the thermal stability increases. Conversely, larger micelles tend to clot, which in turn facilitates the formation of a clot with good syneretic properties [11, 13].

It should be borne in mind that the quantitative and qualitative content of key components of milk that are important in curd technology depends on the breed of the animal, its individual characteristics, its physiological state. The most common breeds of cows on the territory of Russia include the black-motley and black-mottled golshtinized animal breed. According to the Territorial Body of the Federal State Statistics Service for the Oryol Region, the number of cows of black and motley Holsteinized breed in the farms of the Oryol region is 53.6% of the total number of cows. In general, having good productive characteristics, the milk of this breed of cows is inferior to milk produced by such breeds as Yaroslavskaya, Jerse, Kostroma, which, according to experts, are priority for the production of cheese and cottage cheese [6, 12].

In this regard, the increased attention of curd producers should be directed to careful regulation of the quality of milk already during the formation of batches of raw milk in the farms. Superficially localized biologically active centers (SLBACs) on the body of cows can play a certain role in assessing the quality of milk, measuring the bioelectric activity in certain SLBAC, it is possible to predict not only the physiological state of the animal, but also certain technological characteristics of the milk produced. Domestic scientists Guskov A.M., Mamaev A.V., Leshchukov K.A., Ilyushina L.D., Stepanova S.S., Solovyova A.O. discuss the possibility of the existence of a relationship between the level of the bioelectric potential (BP) of the SLBACs with the reproductive capacity of cows, slaughtering qualities, fatness, the content of solids in milk, the technological characteristics of milk fat (fat content, its fatty acid composition and fat globule size) [3, 4, 5, 7, 9].

However, genetic studies of the productive qualities of agricultural animals widely used in animal husbandry practice find very limited application in regulating the quality of raw milk directed to the production of dairy products and in particular to the production of cottage cheese. Therefore, to evaluate the quality of raw milk at the stage of forming batches of milk intended for the production of cottage cheese (based on the protein content and the fractional composition of the protein), it may be promising to use the level of bioelectrical potential (BP) of surface-localized biologically active centers (SLBFACs).

II. MATERIALS AND METHODS

The experiment was carried out on the basis of the "Streletskoe" farm of the research institute of leguminous and cereal crops in the Orel region. The value of the bioelectric potential (BP) was measured by means of an electrical measuring instrument of the ELAP type by the author's method. A.M. Guskova, A.V. Mamaev. The determination of the æ-casein locus was carried out by polymerase chain reaction (PCR) analysis. Polymorphism of the æ-casein gene was studied by the method of N.A. Zinovieva, E.A. Gladyr. in accordance with the methodological recommendations on the use of molecular genetic test systems for the analysis of polymorphisms of the proteins of milk of cattle. For the study of the bioenergetic status of cows, SLBACs No. 5, No. 7, No. 11, No. 41, and No. 44 were chosen. Localization and numbering of the centers were accepted in accordance with the methodological guidelines of G.V. Kazeeva, E.V. Varlamov and A.V. Starchenkovoy [7]. The control group was an experimental group of animals with a low value of the bioelectric potential level of the SLBACs. The total number of animals with the measured level of the BP SLBACs was 173 heads of Holsteinized black-and-white cows (1-5 lactation). Based on the results of measurements of the BP SLBACs of cows, experimental groups of animals were formed by the method of para- analogues with 6 heads in each, with a low, medium and high level of the BP SPBATs. Experiments on animals were carried out in accordance with the "Rules for carrying out work using experimental animals" (annex to the order of the Ministry of Health of the USSR of 12.08.1977 № 755). The milk of the experimental animals selected from the morning and evening milking was analyzed for protein, fat, fat: protein, SOMO: fat, and æ-casein locus.

III. RESULTS AND DISCUSSION

In the course of the experiment, it was found that for animals of the first lactation, a high level of BP SLBACs is characteristic at high values of the protein mass fraction. With an increase in the level of BP SLBACs at 3.09 mkA in the second group of cows of the first lactation, the protein mass fraction increased by 0.24% compared to the control group. In this case, in the milk of first lactation cows, the tendency to increase the protein content is more pronounced compared with the increase in the mass fraction of fat. In animals of the second lactation, an increase in the mass fraction of the protein was observed at 17.15 and 26.5 mkA (for the second and third test groups) as compared to the control group, by 0.09 and 0.27%.

For the second and third group of cows of the third lactation, the level of the BP SLBACs increased by 10.65 and 28.48 mkA, relative to the control group, the protein mass fraction increased by 0.07 and 0.16%. An increase in the level of the BP SLBACs in the experimental animals of the fourth lactation compared to the controls up to 16.64 and 28.00 mkA for the second and third group of cows promoted an increase in the protein content by 0.11 and 0.19%. In the experimental groups of cows of the fifth lactation, with the increase in the level of the BP SLBACs in comparison with the control at 20.01 and 28.35 mkA, the mass fraction of protein in milk increased by 0.31 and 0.68%, respectively. Optimal ratio of fat: protein, SOMO: fat was noted in the milk of animals of the third group, 2, 3 and 4 lactations (Table I).

TABLE I. RELATIONSHIP BETWEEN THE TECHNOLOGICAL CHARACTERISTICS OF THE MILK OF THE EXPERIMENTAL COWS 1-5 LACTATION AND THE LEVEL OF THE BP SLABAC, (M ± M), N = 6

Group №	BP SLBACs level, mkA	Mass fraction,%		Ratio		*The level of milk availability for the production of cottage cheese*
		fat	*protein*	*fat : protein*	*SOMO : fat*	
1 Lactation						
I	33.12±0.68	3.88±0.07	3.20±0.01	1:0.82	1:0.45	medium
II	36.21±0.71*	4.02±0.21	3.44±0.01***	1:0.86	1:0.45	medium
2 Lactation						
I	7.32±0.67	3.55±0.08	3.16±0.01	1:0.89	1:0.42	low
II	24.47±1.52***	3.68±0.08	3.25±0.01***	1:0.88	1:0.43	medium
III	33.82±1.08***	3.86±0.15	3.43±0.01***	1:0.89	1:0.45	high
3 Lactation						
I	6.37±0,81	3.67±0.07	3.00±0.01	1:0.82	1:0.43	low
II	17.02±1,06***	3.80±0.09	3.07±0.01***	1:0.81	1:0.44	medium
III	34.85±1,35***	3.84±0.07	3.16±0.00***	1:0.82	1:0.45	high
4 Lactation						
I	6.68±1,10	3.57±0.14	3.15±0.01	1:0.88	1:0.43	low
II	23.32±1.,26***	3.63±0.13	3.26±0.01***	1:0.90	1:0.43	medium
III	34.68±0.93***	3.75±0.14	3.34±0.01***	1:0.90	1:0.44	high
5 Lactation						
I	6,22±0.71	3.63±0.23	2.87±0.01	1:0.79	1:0.42	low
II	26.23±0.89***	3.73±0.12	3.18±0.01***	1:0.85	1:0.42	medium
III	34.57±0.77***	4.29±0.59	3.55±0.01***	1:0.83	1:0.49	medium

*P≤0,05; **P≤0,01; ***P≤0,001 (here and below).

Thus, it was established that the higher the bioelectrical potential of the SLBACs, the higher the protein content in milk.

This relationship can serve as a test in assessing the quality of raw milk and the formation of a herd of animals for selection in groups to obtain raw milk, characterized by high technological suitability for the production of cottage cheese.

Therefore, according to the total protein content, milk of the third groups of animals of 2, 3 and 4 lactations is preferable for curd production, milk obtained from animals of the second group of 2, 3 and 4 lactations can be considered acceptable.

In spite of the fact that the level of the BP SLBACs of cows 1 of lactation was higher than the productivity of animals in the fifth lactation, this is largely due to the high growth energy of young animals. The level of suitability of milk for the production of cottage cheese for cows of the fifth lactation can be estimated as "medium", which is due to a gradual decrease in the reserve of their productivity.

Taking into account that not only the total protein content but also its fractional composition is important in the production of cottage cheese, at the second stage of the study, the relationship between the level of the BP SLBACs with the animal genotype at the æ-casein locus was studied (Table II).

TABLE II. INTERRELATION OF THE LEVEL OF THE BP SLBACS OF EXPERIMENTAL GROUPS OF ANIMALS 2, 3 AND 4 LACTATIONS WITH THE GENOTYPE OF Æ-CASEIN, (M ± M), N = 6

Group №		**BP SLABAC level, mkA**	**Genotype of animals based on DNA-diagnostics, number of heads**			**The level of milk availability for the production of cottage cheese**
			AA	***AB***	***BB***	
2nd lactation	1 (c)	6.89±0.62	5	1	–	low
	2	18.90±3.21*	2	4	–	medium
	3	29.82±5.66*	1	4	1	high
3rd lactation	1 (c)	6.76±0.55	4	1	1	low
	2	22.25±2.40**	1	4	1	medium
	3	34.40±0.64***	–	5	1	high
4th lactation	1 (c)	6.60±0.40	5	1	–	low
	2	20.08±4.59*	1	4	1	medium
	3	30.25±6.26*	–	4	2	high

- animals with this combination of genotypes were not found.

As a result of the research, it was established that in animals of the second lactation with low and medium level of the BP SLBACs, only the genotype of æ-casein AA and AB was detected. In the group with a high level of BP SLBACs, all three genotypes of ß-casein were detected. In this case, the incidence of genotypes of ß-casein in animals with a low BP SLBACs level was AA.33.33%, AV16.67%, BB 0%, in cows with an average level of BP SLBACs, 33.33%, 66.67%, 0%, and cows with a high level of BP SLBACs - 16.67%, 66.67%, 16.67%, respectively. In animals of the third lactation in the first and second groups cows with AA, AB and BB genotypes were found. In the third group (BP = 34.85 mkA), the genotype BB and AB was detected, the AA genotype was not detected. The frequency of the genotypes of ß-casein in animals with a low level of BP SLBACs was AA-66.67%, AB-16.67%, BB-16.67%, cows with a high level of BP SLBACs - 0%, 83.33%, 16.67%. In animals of the fourth lactation, the frequency of occurrence of the AA genotype of ß-casein was 83.33% higher in the control group of cows than in the second test group. The number of animals with the AB genotype in the second and third test groups exceeded the control group by 66.67%. Taking into account the established regularities, trial production of cottage cheese from milk of the third group of animals 2, 3 and 4 lactations in which genotypes AA, AB and BB were found was carried out. The milling was carried out at a temperature of 32 ± 2°C. The completion of fermentation was determined after reaching the titrated acidity of the bunch - 60-65 ^{0}T. The readiness of the clot to be processed was determined by breakdown. The qualitative characteristic of the resulting curd bunch is given in Table III.

TABLE III. QUALITATIVE CHARACTERISTICS OF THE CURD DEPENDING ON THE MILK USED

№ группы		**BP SLABAC level, mkA**	**Characteristics of the quality of the clot * depending on the genotype**		
			AA	***AB***	***BB***
2nd lactation	3	29.82±5.66*	Flabby, flaky+	Dense, elastic, with a weak syneresis. Whey transparent++	Thick with a glossy surface, which separates the serum well. Whey transparent +++
3rd lactation	3	34.40±0.64***	Flabby, flaky+	Dense, elastic, with a weak syneresis. Whey transparent++	Thick with a glossy surface, which separates the serum well. Whey transparent +++
4th lactation	3	30.25±6.26*	Flabby, flaky+	Dense, elastic, with a weak syneresis. Whey transparent++	Thick with a glossy surface, which separates the serum well. Whey transparent +++

* +++ a good quality clot; ++ clot of satisfactory quality; + clot of unsatisfactory quality.

In the course of the experiment, it was found that the best syneretic properties were characterized by a curd clot obtained from milk of cows with genotype BB - 2, 3, 4 lactations. The clot had a glossy surface, a smooth, even edge with a trowel with a spatula. The whey is clear. The required level of titratable acidity was reached after 5 hours and 12 minutes.

Unsatisfactory characteristics had a clot, obtained from milk of cows with the AA genotype, the time of fermentation was 8 hours, 25 minutes. A dense, elastic clot was obtained from the milk of cows with the AB genotype, however, until the required level of titrated acidity was reached, it took more time than the curd brew obtained from the milk of cows with the genotype BB - for 30 minutes.

As studies have shown, the maximum yield of finished cheese (kg of 100 kg of milk) was obtained from milk of the third lactation period. At the same time, in the milk of animals with the genotype of BB, regardless of the lactation period, the yield of the finished product increased by 8%, compared with the milk of animals with the genotype of AB and AA æ-casein. The yield of the finished product depending on the lactation period and the æ-casein genotype in milk is shown in figure 1.

IV. CONCLUSION

The application of the bioelectric potential measurement method for assessing the suitability of milk in the production of cottage cheese made it possible to identify the following patterns:

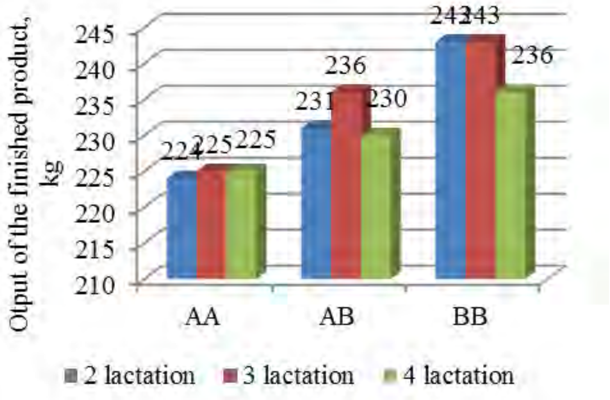

Fig I. Yield of the finished product depending on the lactational period and the æ-casein genotype

First, the increase in the productivity of cows occurs during four lactations, which is associated with the realization of genetic potential. The highest productivity, the maximum protein content and the optimal ratio between the fat content: protein, fat: SOMO is fixed in the milk of animals of the third group of 2, 3 and 4 lactation.

Secondly, a correlation was established between the level of the average bioelectrical potential of the BP SLBACs cows and the ß-casein genotype. At high values of the level of the average of the BP SLBACs, the frequency of occurrence of genotypes AB and BB of ß-casein increases, which indirectly indicates an increased protein content in milk.

Thirdly, taking into account the established regularities, it is advisable to use milk obtained from animals of the third groups of the 2nd, 3rd and 4th lactations with the BB genotype, it is acceptable to use milk obtained from animals of the third groups of 2, 3 and 4 lactations with the genotype AB.Before you begin to format your paper, first write and save the content as a separate text file. Keep your text and graphic files separate until after the text has been formatted and styled. Do not use hard tabs, and limit use of hard returns to only one return at the end of a paragraph. Do not add any kind of pagination anywhere in the paper. Do not number text heads-the template will do that for you.

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